63-3-1

IN CORRESPONDENCE REGARDING THIS REP
REFER TO: ARTC/R&D RPT NO. 244

(5) 536 300 MCDONNELL AIRCRAFT CORPORATION

(6) Molybdenum Structural Component Program

(12) Contract No.: NOw61-0653-t
Task Order No.: 61-2

(7) Progress Report
Covering Period
1 February 1962 to 1 May 1962

TABLE OF CONTENTS

(8) NA
(9) 1 May 62.
(10) 7 pp. incl. illus. tables
(11) NA
(13) NA
(14) Unc.
(15) NA

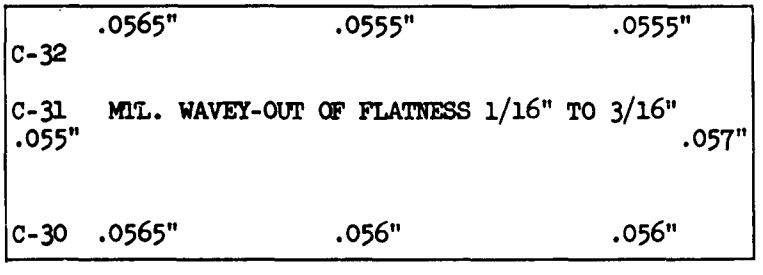
$1.10

ABSTRACT

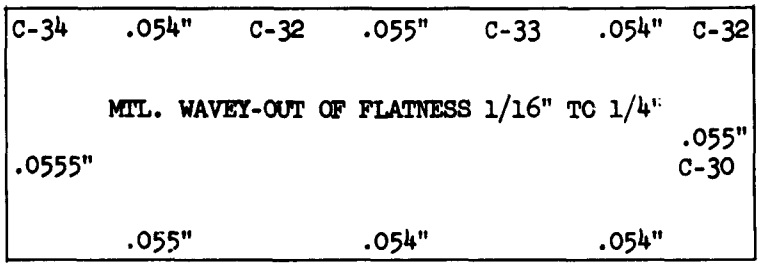
This report covers work accomplished under Contract NOw61-0653-t, Task Order No. 61-2 for the third reporting period. Three pre-production Mo-0.5%Ti sheets (25#), which were received from Universal Cyclops at the end of the last period, were processed to determine flatness, hardness, thickness variation, tensile properties at room and elevated temperatures and formability by bend tests. Major layouts and structural analyses were completed for the test elements, test box, test panels, and rudder substructure.

1. Mo-0.5%T1 Sheet

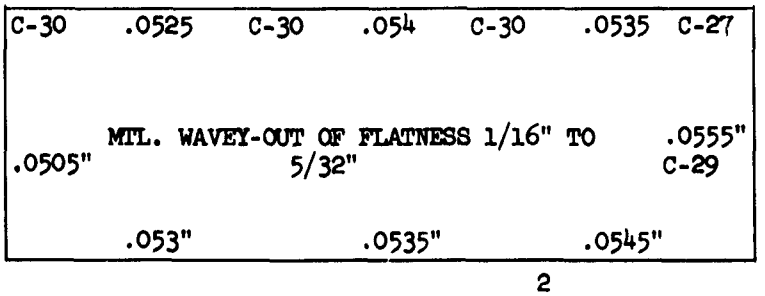
As mentioned in the preceding report, three (12" x 36") pre-production sheets of .055 gage Mo-0.5%T1 were received at McDonnell for preliminary evaluation. Initially, these sheets were thought to be representative of the production sheets to be rolled. Subsequent information established that these three sheets were partially recrystallized, therefore, mechanical properties are lower than those anticipated for the production sheet. In the M.A.C. receiving inspection, the sheets were checked for flatness, hardness, and surface defects. Longitudinal and transverse bend tests were made on specimens from each sheet using 1.0 x 4.0 in. specimens and bending 105° over a 3T radius at room temperature. No failures occurred in these six tests. The following sketches depict the thickness, flatness, Rockwell hardness, and surface condition as reported for each sheet. The range in Rockwell hardness is probably from varying degrees of recrystallization in the sheet.



SHEET #1
Lamination - One Edge
Surface Good



SHEET #2
Lamination on 3 Edges
Surface Good



SHEET #3
Lamination - One Edge
Surface Good

Longitudinal, transverse, and 45° tensile tests were run for each sheet at both room and elevated temperatures (3000°F). Tensile test results are listed in the following table. The wide spread in results is attributed to the varying percent of recrystallization in the sheet.

Tensile Test Results						
	3000°F			Room Temperature		
Specimen	Fty	Ftu	Elong.	Fty	Ftu	Elong. %
1 -45°	3720	6130	59	90,500	110,000	18
2 -45°	3980	7130	54	87,000	104,500	20
3 -45°	4950	8100	49	80,500	95,000	4 (BOG)*
1 - T	4260	6540	63	102,000	111,500	13
2 - T	5030	7830	62	83,000	108,500	17
3 - T	4100	6360	62	89,500	103,000	17
1 - L	4150	5750	82	90,500	116,500	19
2 - L	5100	6630	61	91,000	112,000	20
3 - L	5320	7090	63	82,500	100,500	27

* Broke out of gage

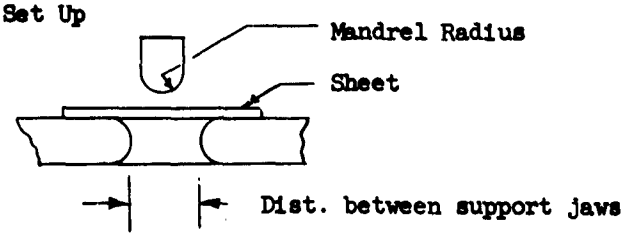
2. Bend Test

In addition to the less stringent run in Receiving Inspection using narrow (1.0 inch) specimens, wide bend specimens (2.5 x 3.0 inches) were prepared to determine room temperature bend characteristics of the material. Specimens were chem-blanked to size, edges were rounded using a belt grinder, and then bent parallel to the grain using various radii and strain rates. The successful specimens were bent to 130° and after spring back were at approximately 122°. These parts that cracked or broke have the angle at which failure occurred noted. Since these specimens were prepared from pre-production sheets with a varying percentage of recrystallization, results were varied and scattered; therefore, no additional bend testing will be done until the production sheets are delivered. The results of these tests are shown in the following table.

TR 185-007 Bend Test .055 Mo-0.5%Ti

1 Spec. No.	2 * Mandrel Radius (in)	3 * Distance Between Jaws (in)	4 Form. Rate (in/min)	5 Equipment Used	6 Results	7 Bend Angle (Degrees)
1	.062	.270	6	Press Brake	Broke	60
2	.172	.490	6		Broke	20
3	.219	.580	6		Broke	40
4	.281	.705	6		Successful	130
5	.281	.705	144		Broke	15
6	.219	.578	6		Cracked	15
7	.281	.705	6		Successful	130
8	↓	↓	6		Successful	130
9	↓	↓	6		Cracked	25
10	↓	↓	6		Cracked	25
11	.344	.831	6	Baldwin Tensile Test Machine	Cracked	30
12	↓	↓	6		Successful	130
13	↓	↓	6		Broke	10
14	↓	↓	6		Broke	60
15	↓	↓	6		Broke	15
16	.500	1.143	6		Successful	130
17	↓	↓	6		Broke	85
18	↓	↓	6		Broke	20
19	↓	↓	6		Cracked	105
20	↓	↓	6		Successful	130
21	↓	↓	6		Successful	130
22	↓	↓	6		Broke	25
23	.5625	1.268	6		Cracked	35
24	↓	↓	6		Broke	55
25	↓	↓	6		Broke	20
26	↓	↓	6		Successful	130
27	↓	↓	6		Broke	65
28	↓	↓	6		Cracked	55
29	↓	↓	6	↓	Broke	80

* Sketch of Test Set Up



3. Evaluation of Pre-production Sheets

These sheets were delivered as pre-production sheets by Universal Cyclops and are not indicative of sheets to be used later on in this program. The results reported here

are varied and non-conclusive because of the varying degrees of recrystallization in the sheet. The low mechanical properties, lack of ductility, wide scatter of properties due to varying amounts of recrystallization and edge laminations would make these sheets unacceptable as good production sheets. These tests have been useful in setting up and checking out equipment to be used when the production sheets are delivered and evaluated.

4. Structural Design

A major part of the effort during this quarter was concentrated on the design of structural elements for test, the test box, and the rudder component. The materials presently planned to be used for the rudder are:

Outboard panels - Mo-0.5%Ti
Substructure - TZM
Hinge Fittings - FS-82
Rib-mid Spar Fittings - FS-82
Fasteners - TZM
Inboard panels (not loaded) - L-605

As a result of the number of gages of material to be supplied being decreased from eight to four, the amount of material required from each gage is changed as noted:

Gage	Mo-0.5%Ti (lb)	TZM (lb)
.016	256.0	231.0
.020	27.5	41.5
.040	35.9	140.0
.060	74.1	144.0
Total	393.5	556.5

Since the TZM alloy has better mechanical properties than Mo-0.5%Ti it will be used in the ribs and spars where strength is necessary. Outboard panels on the rudder component will be made of Mo-0.5%Ti. With the minimum gage thickness, ample strength can be obtained in the panels using Mo-0.5%Ti, except for the skin-corrugation attachments. Inboard panels, since they carry no load and need only to withstand the temperature, will be made of L-605.

The hinge fittings and ribs-mid spar intersection fittings will be made of FS-82. The temperature in these areas will permit the use of columbium and a much simpler fitting can be made by welding.

5. Information from Other Programs at M.A.C.

Blanking of molybdenum parts by chem-milling and using a photosensitive mask has been successfully accomplished at M.A.C. An early problem of incomplete bonding of the mask along part edges has been corrected and satisfactory blanked production parts are now being obtained.

Two test panels, one Cb-5%Zr and one TZM, have been fabricated and will be tested in the near future for another program at M.A.C.

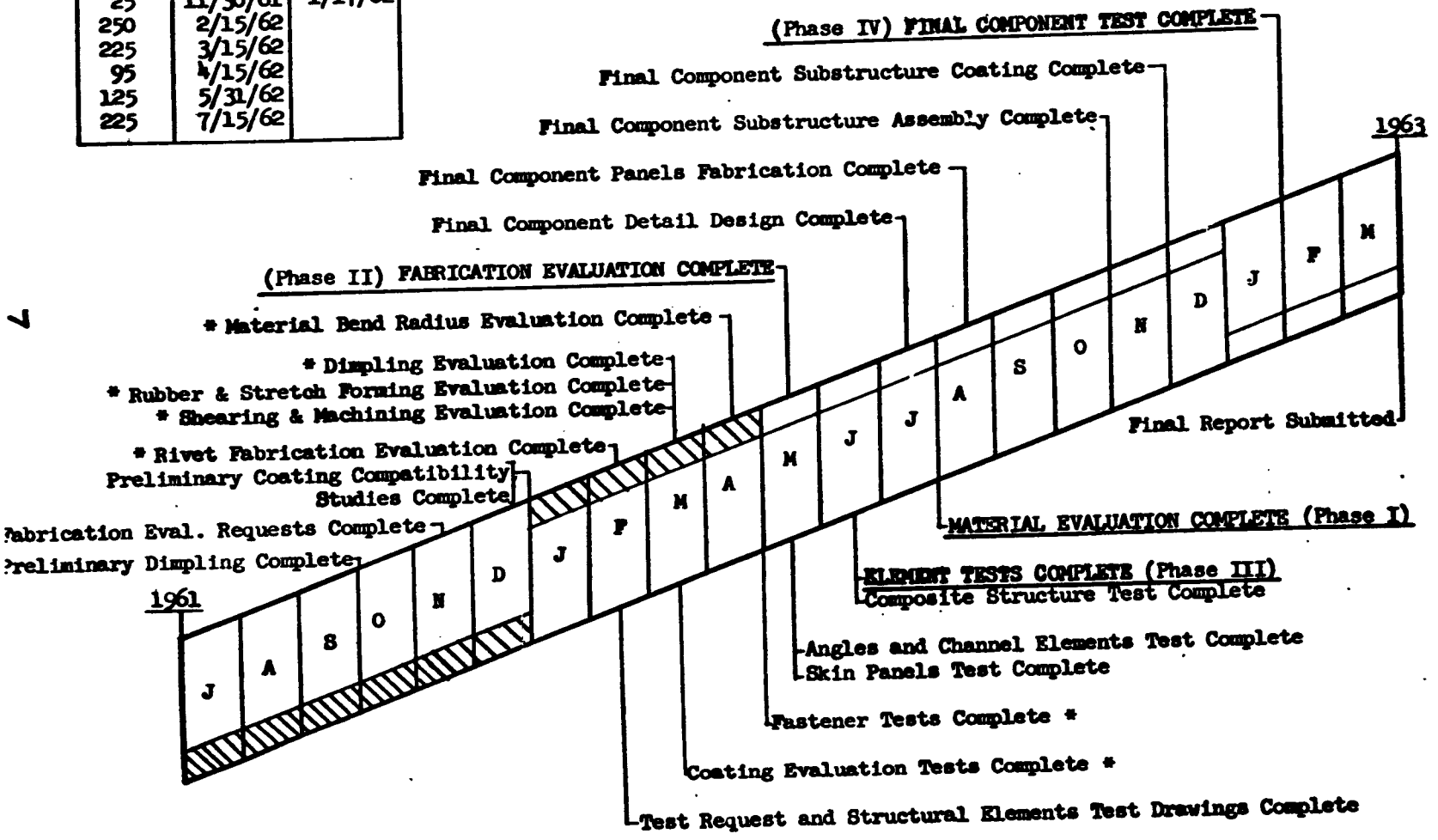
Some special TZM .020 sheets have been received at M.A.C. Room temperature bend tests have been accomplished using a 2 and 2.5T bend radii.

6. Schedule

Since the items scheduled on the Milestone Chart for completion during this report period were dependent on using material which was not delivered, none of the items were accomplished. Work is continuing on the design and analysis of the final component and is on schedule. The Milestone Chart will be up-dated when revised material delivery dates can be established.

Material Requirements		
Pounds	Req'd Date	Rec'd Date
25	11/30/61	1/17/62
250	2/15/62	
225	3/15/62	
95	4/15/62	
125	5/31/62	
225	7/15/62	

MILESTONE CHART



* Items planned for third quarter were not accomplished because production material was not available.